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— Est. 2010 —

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JMTE WAYN 1489
TECHNICAL MEMORANDUM

July 24, 2024

TO: Legacy at Jordan Lake HOA
4112 Blue Ridge Road, Suite 100
Raleigh, NC 27612
Attn: Sabrina Kuratanap
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FROM: David W. Hyder, P.E., Engineering Director David W. Hyder, P.E.
J.M. Teague Engineering & Planning

SUBJECT: LEGACY AT JORDAN LAKE TRAFFIC CALMING STUDY (WAYN 1489)

The Legacy at Jordan Lake Homeowner's Association (the Client) reports speeding and other traffic-related issues and would like a range of options that improve the community. The Client's vision of the community is a high-end community that is safely walkable. Working towards their vision for the community, the Client has retained J.M. Teague Engineering and Planning to develop a traffic calming plan for the Legacy at Jordan Lake. Figure 1 shows the development, and the traffic count locations are shown as blue circles.

FINDINGS

The Engineer found that:

- Observed speeds are as much as eight miles per hour above the posted speed,
- Neighborhood signage does not comply with the Manual on Uniform Traffic Control Devices (MUTCD),
- Crosswalks and trailhead markings do not meet the requirements of the MUTCD,
- The intersection of Legacy and Legacy Falls Drive could benefit from channelization,
- Some sight triangles are overgrown and need to be cleared for safety,
- One blind vertical curve needs to be better marked to improve safety,
- There is evidence of subgrade failure on some roadways, and
- Some drainage structures are obstructed and can cause hazardous conditions during rain events.

This report documents the Engineer's work and discusses a range of traffic calming tools that the Homeowner's Association (HOA) may implement to lower vehicle speed and improve walkability.

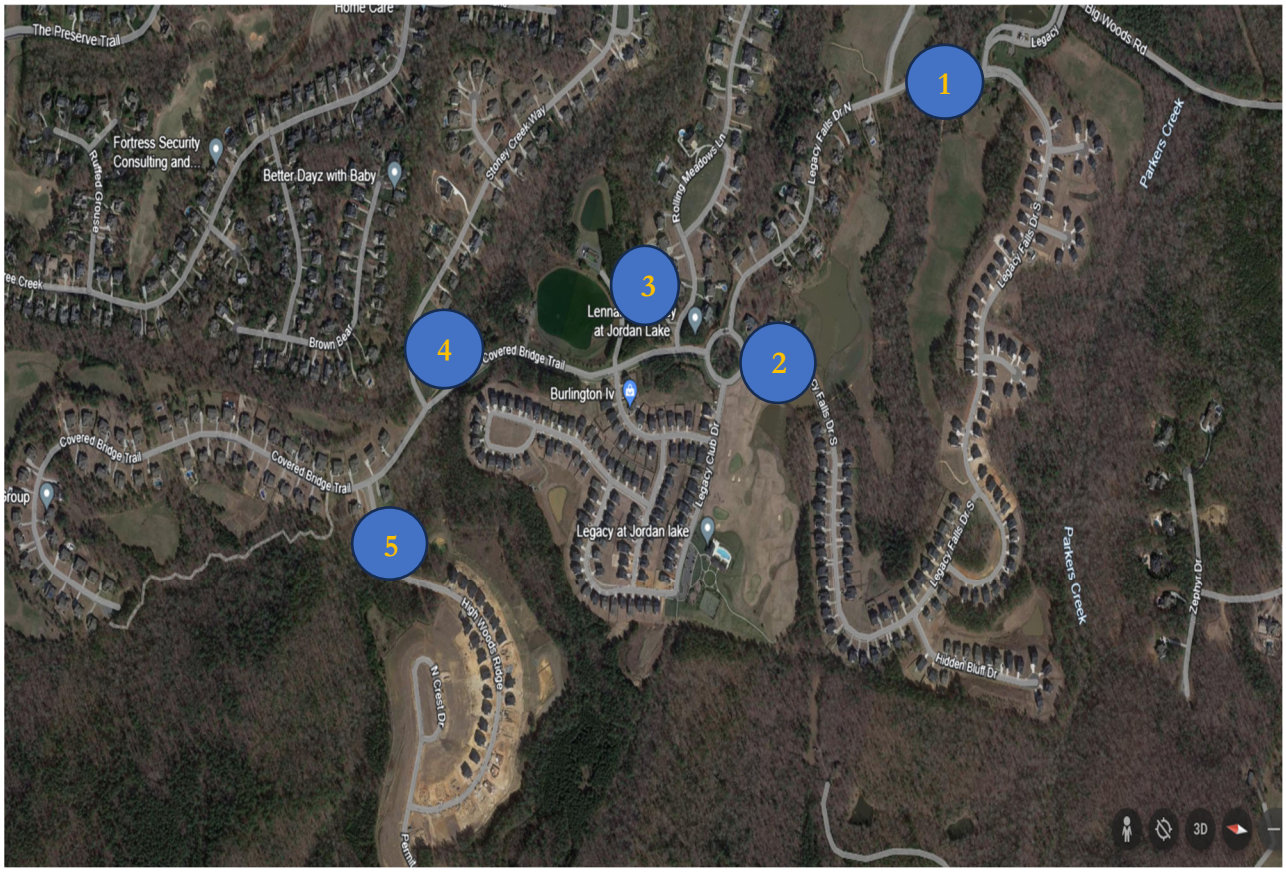


Figure 1: Legacy at Jordan Lake Count Locations & Numbers Shown in Blue (Source: Google Earth)

EXISTING CONDITIONS

The Legacy at Jordan Lake is a gated residential community. The HOA owns and maintains all of the streets within the development. The streets are generally 20-foot wide paved, two-lane, and two-way. Legacy Falls Drive North, and Legacy Falls Drive South have a grassed median near the main entrance. Many of the roads in the development have a 5-foot concrete sidewalk on one side. There are no bike lanes or bike paths on the studied roads. The posted speed limit throughout the subdivision is 23 MPH:

Figure 2 Posted Speed Limit

STUDY METHOD

The study consisted of a site visit, collecting traffic count data (speed, volume, and vehicle classification, evaluating the data collected, comparing various traffic calming measures with the community vision, and recommending changes to improve speed and safety.

SITE VISIT

The Engineer conducted a site visit with the Client on Wednesday, February 7, 2024. The weather was clear with a low temperature of 28° F and a high temperature of 55° F. The conditions were sunny to partly cloudy.

During the site visit, the Engineer met with the Client, discussed their objectives for the review, measured pavement width, measured shoulder width, identified potentially hazardous conditions, noted general maintenance conditions, and photographed notable locations in the community.

TRAFFIC COUNTS

The Engineer installed pneumatic tube vehicle speed and classification systems (count tubes) at five locations:

- Legacy Falls Dr. North, near the entrance of Legacy,
- Legacy Fall Dr. South of Westlake Circle,
- Covered Bridge Trail north of Rolling Meadows Lane,
- Covered Bridge Trail south of Stoney Creek Way, and
- High Woods Ridge, as shown in Figure 1.

The Engineer collected data from Tuesday, January 30, 2024, through Thursday, February 1, 2024.

SUMMARY DATA ANALYSIS

Figure 3 shows the relationship between vehicle speed and pedestrian injury.

Figure 4 summarizes the comparison between the 85th percentile speed and the posted speed. As can be seen, the observed speeds are between four and eight miles per hour higher than the posted speed. The observed speeds are high enough to increase the risk of injury in case of a vehicle-pedestrian crash.

A more complete summary of the data collected is included in Appendix B.

Figure 3: Vehicle Speed vs. Risk of Pedestrian Injury

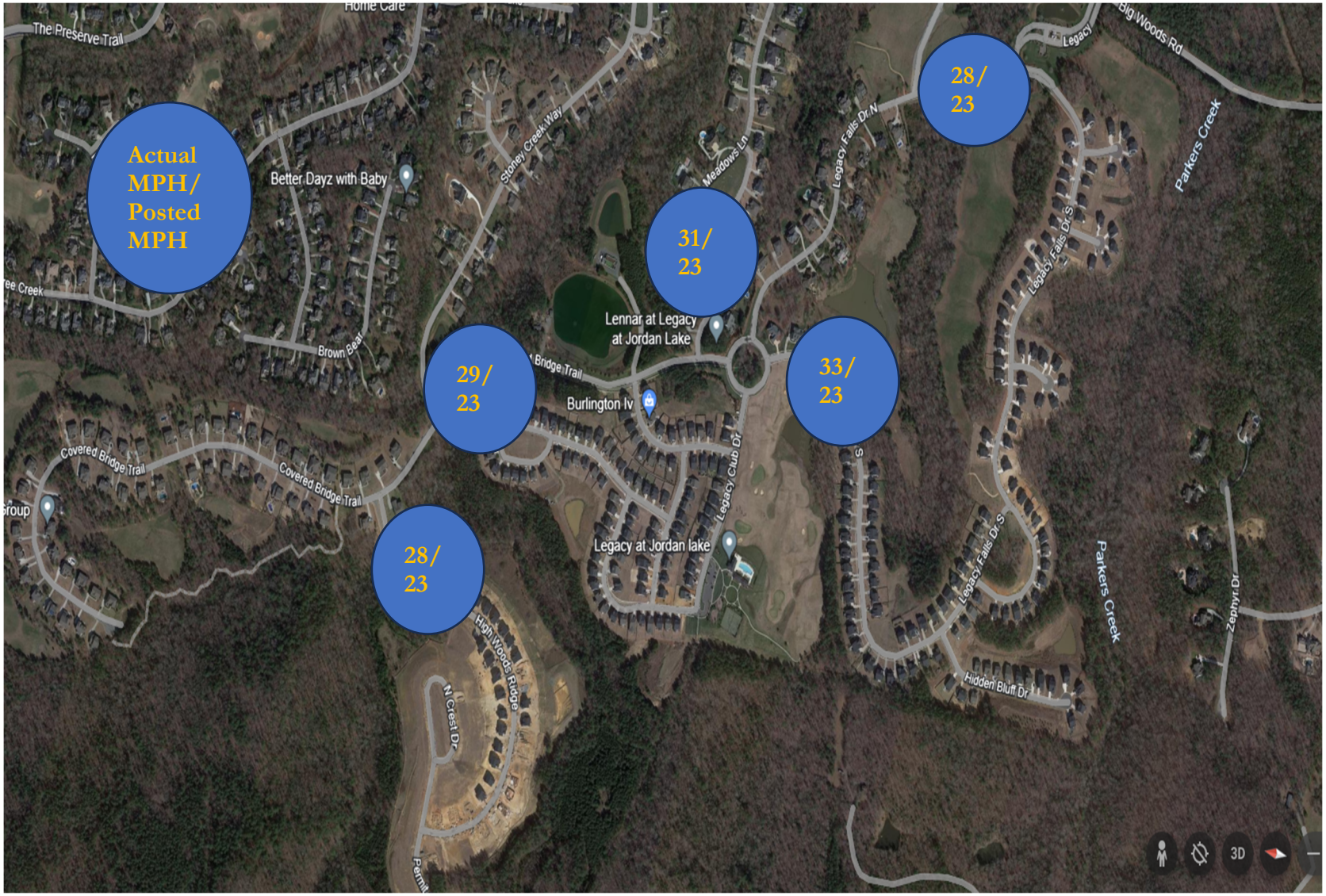


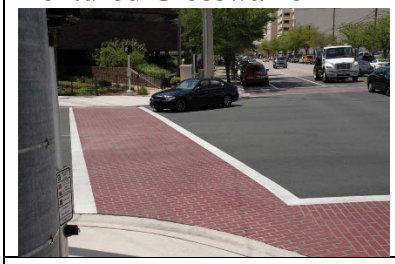
Figure 4: 85th Percentile vs. Speed Limit

MITIGATION ANALYSIS

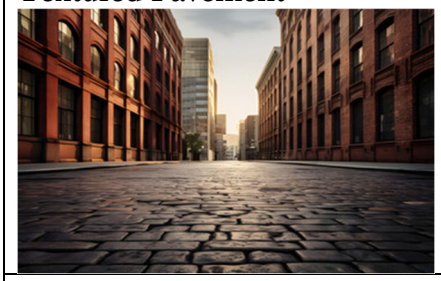
The Engineer considered different mitigation options including speed enforcement, speed humps, speed tables, speed cushions, and speed feedback signs. Table 1 shows the mitigation options considered, the anticipated speed reduction, unit cost, number of recommended units, and total cost.

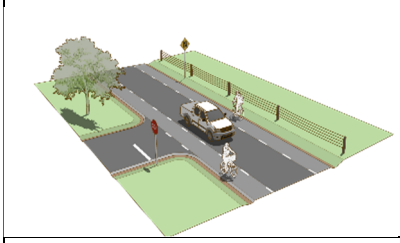
Table 1: Traffic Calming Options

Options	Description & Effect	Pluses	Minuses
Policy Actions			
Speed Enforcement 	Reduces speed in the area of enforcement		
Pluses	Commonly available on public streets.		
Minuses	Enforcement may not be available on non-public streets. Speeding usually resumes once Enforcement stops.		
Changing the speed limit	Changing the posted speed limit to match the 85th percentile speed.		
Pluses	Matches the legal speed limit to the prevailing speed.		
Minuses	Changing the speed limit, without other measures, has only a small effect on the 85th percentile speed. This may be seen as giving in.		
Speed Feedback Signs 	A dynamic speed limit sign		
Pluses	Speed feedback signs make drivers more aware of their speed.		

Options	Description & Effect	Pluses	Minuses
Minuses	Speed feedback signs may be either permanent or temporary. Both types lower speeds. However, with temporary signs (AKA speed trailers) the reduction is temporary[1].		
Pavement & Pavement Marking			
Textured Crosswalks 	Stamped pavement, brick pavement, or cobblestone surfaces		
Pluses	These installations provide a good visual and tactile indication of the crosswalk.		
Minuses	Textured crosswalks do not lower speeds. They improve safety by making crosswalks more visible. Expense varies by material Some materials (brick or cobblestones) are hard for wheelchair users and the visually impaired to use. Maintaining brick pavers, or cobblestones can be costly.		
High Visibility Crosswalks 	High visibility crosswalks use wide vertical or zebra stripe lines to emphasize the pedestrian area of a roadway.		
Pluses	Focused installation, improve pedestrian safety		
Minuses	High-visibility crosswalks may be more costly to maintain. In the simplest case only, more paint is involved. More comprehensive installations include pedestrian refuges and flashing beacons that need skilled maintenance often.		

[1] https://www.nhtsa.gov/book/countermeasures-that-work/speeding-and-speed-management/countermeasures/other-strategies-behavior-change/dynamic-speed

Options	Description & Effect	Pluses	Minuses
Textured Pavement 	Stamped pavement, brick pavement, or cobblestone surfaces		
Pluses	Textured Pavements can reduce vehicle speeds over an extended length Well-designed textured pavements can improve the neighborhood's esthetics.		
Minuses	Expense varies by material. They can make crossings more difficult for wheelchair users and the visually impaired.		
	Lateral Deflection		
Lane Chokers & Bulb-Outs 	Bulb-outs (also called curb extensions) extend the sidewalk into the parking lane to narrow the roadway and provide additional pedestrian space and visibility at key locations.		
Pluses	May be implemented on a test basis at a low cost.		
Minuses			
Chicanes 	A chicane introduces a curving path into an otherwise straight road causing a driver to weave back and forth to negotiate the street. Chicanes can reduce the 85th percentile speed between 3 and 9 miles per hour (Source: FHWA).		
Pluses	Chicanes reduce the likelihood of a crash, can be visually appealing, and visually narrow the road. Chicanes do not cause passenger discomfort or vehicle damage.		

Options	Description & Effect	Pluses	Minuses
Minuses	Drivers may "hog the lane" to maintain speed. Chicanes are long, need to be designed carefully, and can slow emergency response time.		
Advisory Shoulder 	The shoulder is delineated by pavement marking and optional pavement color. Motorists may only enter the shoulder when no bicyclists are present and must overtake these users with caution due to potential oncoming traffic.		
Pluses			
Minuses			
Conventional Roundabout 	Roundabouts can lower speeds by as much as 25 miles per hour and crashes by as much as 80%. Conventional roundabouts have a center diameter of more than 90 feet.		
Pluses	Significantly slows traffic, and significantly slows traffic, without capacity loss.		
Minuses	Cost (up to $2,000,000 per installation) and land uptake (as much as a ¼ acre).		
Mini-Roundabout 	Roundabouts can lower speeds by as much as 25 miles per hour and crashes by as much as 80%. Mini roundabouts have a center diameter of less than 90 feet with a raised island. Micro-roundabouts have a center diameter of fewer than 60 feet with a traversable island.		
Pluses	Significantly slows traffic, and. significantly slows traffic, without capacity loss		
Minuses	The minuses are similar to those of conventional roundabouts but are generally lower cost.		
Vertical Deflection			
Raised Intersection	These devices use a vertical deflection to force drivers to slow down.		

Options	Description & Effect	Pluses	Minuses
			
Pluses	Reduces speed to 15-20 mph when crossing. Improves pedestrian safety, and improves the visual appeal of the street.		
Minuses	Raised intersections negatively affect driver comfort, increase noise[2] , and may change traffic patterns[3]. These devices slow first responders, are expensive to install, and are difficult to remove if found to be undesirable		
Speed Table 	These devices use a vertical deflection to force drivers to slow down.		
Pluses	Reduces speed to 15-20 mph when crossing		
Minuses	These devices slow first responders, are expensive to install, and are difficult to remove if found to be undesirable		
Speed Cushions 	Speed cushions use vertical deflection to force drivers to slow down. The spacing		
Pluses	Reduces speed to 15-20 mph when crossing, and do not slow emergency vehicles		
Minuses	Speed cushions negatively affect driver comfort, increase noise[2], and may change traffic patterns[3].		

[2] Caused by vehicles slowing down and speeding up.
[3] Caused by drivers trying to avoid the speed hump.

Options	Description & Effect	Pluses	Minuses
Speed Hump 	Speed humps vertical deflection to force drivers to slow down.		
Pluses	Reduces speed to 25-35 mph when crossing		
Minuses	Speed humps negatively affect driver comfort, and emergency response times, and potentially increase noise,[2] and may change traffic patterns[3]. Speed humps may also damage vehicles especially those with low clearance or heavily loaded vehicles.		

RECOMMENDATIONS

This section of the report presents the Engineer's recommendations. Recommendations are divided into two categories: traffic calming (the focus of the report) and other recommendations (based on observations made during the site visit).

TRAFFIC CALMING

The Engineer recommends that the Client use an incremental approach to effectively balance cost and benefit. The incremental approach allows the HOA to assess options before committing to an expensive solution that they will have to live with. Using that principle the Engineer recommends that the HOA temporarily install lane chokers at 1, 2, 3, 4, 5, and 6 on Figure 5. The HOA can assess chokers using orange construction barrels, skinny cones, or other temporary devices. Based on field observations at Location 6, the Engineer recommends testing two (2) lane chokers on Legacy Falls Drive South due to the proximity to the main entrance. If the temporary installations slow traffic they can be made permanent by installing bulb-outs at those locations. If the chokers do not affect traffic, the HOA can move to the options discussed in Table 2

A mini-roundabout is recommended at the entrance of the development, see the position marked MR in Figure 5. The intersection is large enough for a mini roundabout.

Speed tables, speed humps, or speed cushions should be spaced 250-600 feet apart and more than 150 feet away from an unsignalized intersection. The calming device locations should be adjusted in the field. Recommended locations for traffic calming devices are shown in Figure 5.

Costs are for comparison only, a contractor's quote will account for current conditions.

Table 2: Traffic Calming Recommendations

Traffic Calming Device	**Location of Installation (**Figure 5**)**	**Recommended # of Units**	**Unit Cost for Comparison**
Speed Hump	Not Recommended	0	N/A
Speed Table	Not Recommended	0	N/A
Speed Cushions[4]	Locations 1,2,3,4 & 6	Up to 12	$4,000
Speed Feedback Signs	Locations 5 & SF	2	$3,500
Mini Roundabout	MR	1	$550,000
ADA Ramps		1	$3,000
Crosswalk Striping	Various		$10 Per Linear Foot
Crosswalk Signage (Mid-Block Crossing)	North Crest Drive & Legacy Club Drive	(6) W11-2 & (6) W16-7p	$3,000
Hill Blocks View (W7-6) Advance Warning Signs	178 Stoney Creek Way	2	$600
Tree Pruning	2 areas	N/A	N/A
Intersection Corner grading	1	N/A	N/A

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[4] The speed cushion locations should be adjusted in the field

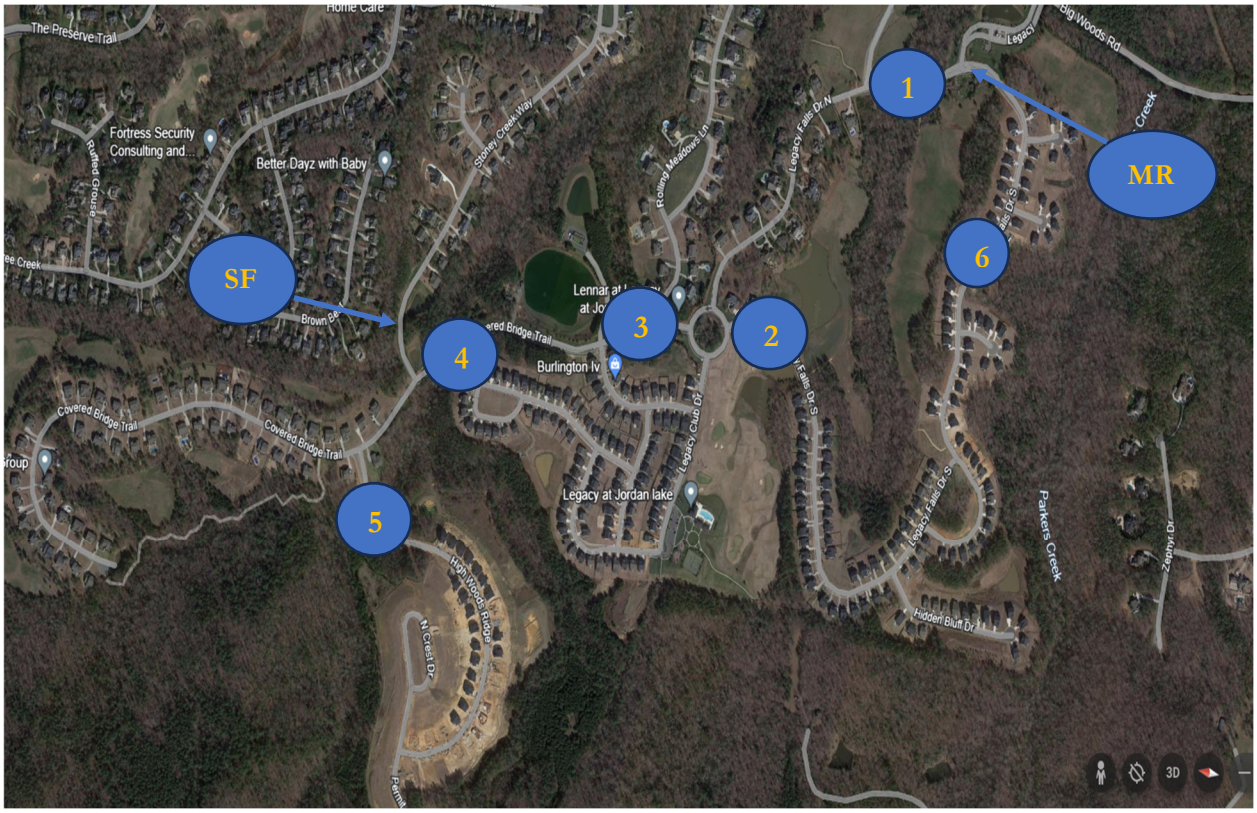

Figure 5: Traffic Calming Mitigation Locations

The Engineer recommends installing two (2) speed feedback signs, one is near location 5 driving into High Woods Ridge past the mailbox cluster and before the first house. The second location is on Stoney Creek Way just past the intersection of Covered Bridge Trail (marked SF).

OTHER CONCERNS

The recommendations presented below address other conditions noted during the site visit. These include sight distances, crosswalks and trailheads, mailbox access, drainage issues, and pavement issues.

SIGHT DISTANCE

The Engineer noted three intersections and a vertical curve with limited sight distance. Three intersections in the development have sight distance issues.

As shown in Figure 6 overgrown ornamental plants obscure the sight distance on Stoney Creek Way at the loop. The HOA should remove these plants.

Figure 6: Obscured Sight Triangle Stoney Creek

As shown in Figure 7 overgrown ornamental plants obscure the sight distance on Overgrown ornamental plantings obscure the sight distance at Rolling Meadows.

Figure 7: Obscured Sight Triangle Rolling Meadows Lane and Rolling Meadows

Site Distance is also a concern at Rolling Meadows Lane and Covered Bridge Trail (Figure 8) The Engineer recommends grading the embankment by removing the top 3-5 feet along a 3:1 slope.

Figure 8: Obscured Sight Distance Rolling Meadows at Covered Bridge Trail

There is a blind vertical crest curve near 178 Stony Creek Way. The Engineer recommends installing a centerline painted stripe at this location to guide drivers cresting the hill from either direction.

CROSSWALKS AND TRAILHEADS

The Engineer noted several unmarked trailheads and trail crossings. Figure 9 is an example location. The Engineer recommends that the HOA install American with Disabilities Act (ADA) compliant curb ramps, high visibility crosswalks, and advanced warning (MUTCD RS-068) signs on both approaches to trailheads.

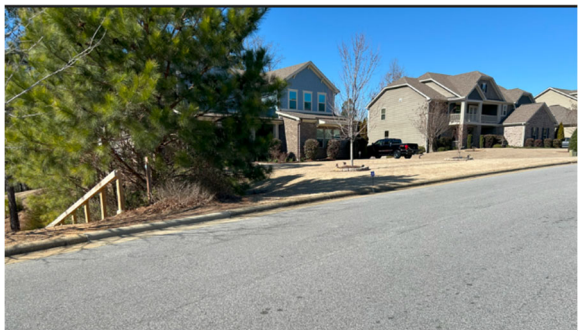

Figure 9: Stoney Creek Way Trailhead

North Crest Drive has two unmarked crosswalks Figure 10) The first is near the North Crest Drive loop and the second is near the High Woods Ridge intersection with North Crest Drive. The cost in Table 4 is for signs only and does not include pavement repair.

Legacy Club Drive near Village Walk Drive has a mid-block crosswalk that needs to be striped and signed in accordance with the MUTCD.

Figure 10: Unmarked Crosswalk

The community should consider the installation of a driver pull-off and crosswalk at the mailbox cluster on High Woods Ridge. The area would need to be widened with curb and gutter removed and reinstalled including additional pavement for parking up to 2 to 4 cars and a crosswalk. See Figure 11.

Figure 11: High Woods Ridge Mailbox Cluster

The Engineer recommends that all roundabout crosswalks be striped. This will enhance pedestrian safety.

Figure 12: MUTCD R2-1 (Speed Limit)

SIGNAGE

The all-way stop at the intersection of Stoney Creek and Covered Bridge Trail is difficult to enforce and may not be warranted absent an Engineer's report. The Engineer does not recommend the use of Stop signs for traffic calming.

The neighborhood needs more speed limit signs. The existing speed limit signs (Figure 2) are not *MUTCD*. The HOA should replace these signs with compliant R2-1 signs see Figure 12.

DRAINAGE AND PAVEMENT ISSUES

During the site visit the Engineer noted drainage and pavement issues that the HOA should have addressed. The curb inlets at the bridge on High Woods Ridge Road are blocked. This is done as an erosion control measure during construction. The Engineer believes that High Woods Ridge Road is still under construction because the final layer of asphalt has not been placed. However, water could pool here during major storms and create a hazard. The curb inlets should be opened as soon as practical, or when the final layer of pavement is placed. The HOA should monitor this location and close the road in the event of standing water.

Figure 13: High Woods Ridge Road Curb Inlets

Pavement and subgrade failures are evident near 55 Permit Court, 143 Permit Court, and 163 Permit Court. The HOA should petition the developer to correct this condition and the similar condition on Legacy Falls does not have the final course of asphalt. There are sections with pavement distress caused by utility trenching and pavement failures as a result of subgrade failures.

Figure 14: High Woods Ridge Asphalt

High Woods Ridge Road is 20 feet wide with a curb and gutter. The final layer of asphalt has not been placed, and there is substantial evidence of weathering and alligator cracking. There is a severe pothole at 355 High Woods Ridge Road, see Figure.

CONCLUSION

The Engineer recommends traffic calming features be installed along the major spine roads within the community as outlined in the Recommendations section of the report. There is a speeding problem in the neighborhood, but this can be mitigated with the installation of traffic calming features.

Not all the features or work need to be done at once. The HOA should develop a prioritized plan of action. The plan of action may consider the risk associated with each concern and the cost of the remedy.

Appendix A provides some additional details on selected traffic calming measures. Appendix B shows the speed data analysis.

APPENDIX A: TRAFFIC CALMING DEVICES

SPEED HUMPS

Speed humps create a vertical rocking motion that encourages drivers to slow to a speed at or below the speed limit. The standard speed hump slows vehicles to approximately 15 to 20 mph at each speed hump and 25 to 30 mph in between properly spaced speed humps.

Placement of Speed Humps and Tables in front of homes may not be desirable as vehicles will slow at the traffic calming measure only to speed up after passing it. See Figure 21, Figure 20, and Figure 21.

SPEED TABLES

Speed Tables create a vertical rocking motion that encourages drivers to slow to a speed at or below the speed limit. The standard speed table slows vehicles to approximately 15 to 20 mph at each table and 25 to 30 mph in between properly spaced speed tables. Speed tables (Figures 17 and 18) are longer than speed humps, often 22 feet long with six-foot ramps on either end of a 10-foot flat top. Additionally, MUTCD-compliant advisory signs are also recommended.

Offset speed tables consist of splitting a speed table into two sections at the centerline of the roadway and offsetting the two sections horizontally. Offset speed tables, like traditional speed tables, create a vertical rocking motion that encourages drivers to slow to a speed at or below the speed limit. However, with the inclusion of the horizontal offset, emergency vehicles can maneuver around the speed tables without impacting travel speeds.

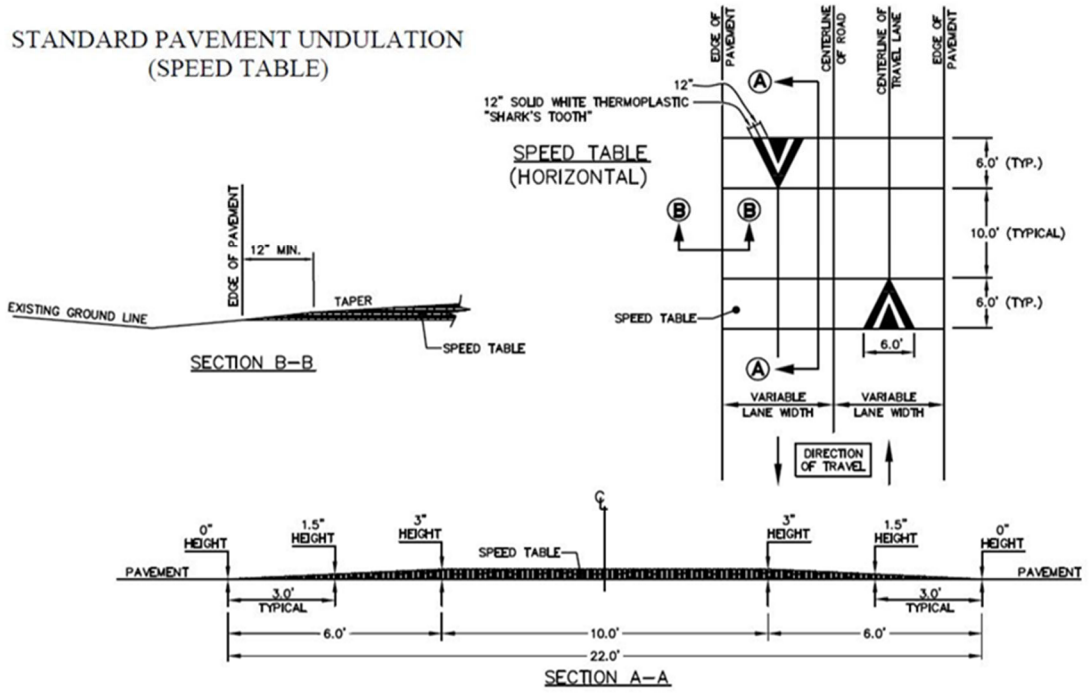

Figure 15: Speed Table Plan and Section Views

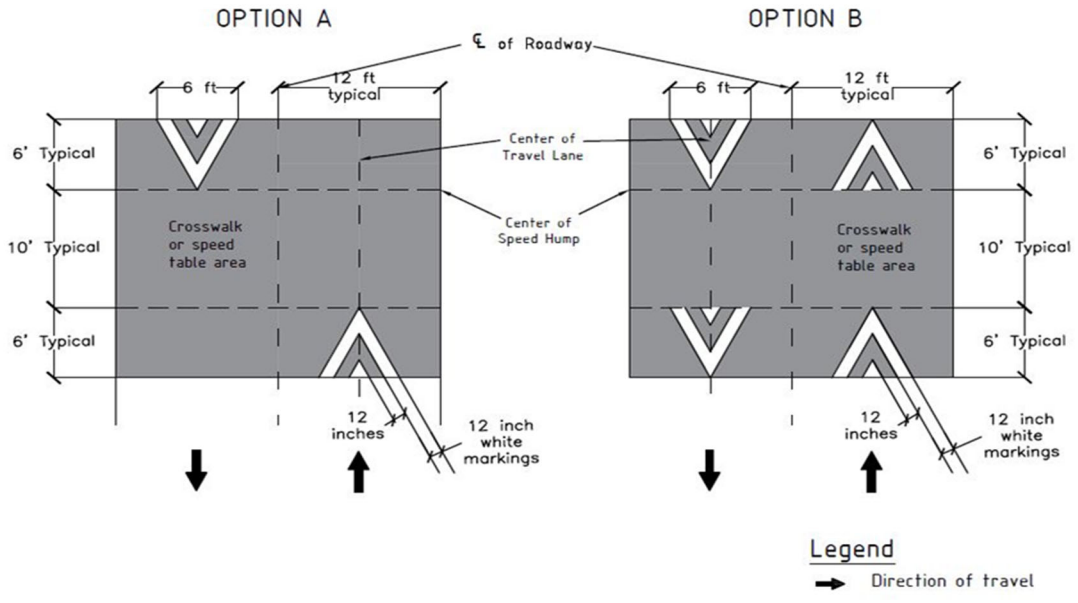

Figure 16: Speed Table Pavement Markings

SPEED CUSHIONS

A Speed Cushion consists of two or more raised areas placed laterally across a roadway. The height and length of the raised areas are comparable to the dimensions of a speed hump. The primary difference between a speed cushion and a speed hump is a speed cushion has gaps (often referred to as "cutouts") between the raised areas to enable a vehicle with a wide track (e.g., a large emergency vehicle, trucks, and buses) to pass through the feature without any vertical deflection. Another difference between a speed cushion and a speed hump is the top of the speed cushion is level. See Figure 19: Speed Cushion.

Like a speed hump, the profile of a speed cushion is gentle enough to provide a comfortable ride when traversed at a speed of approximately 20 to 25 mph. The cutouts in the speed cushions are positioned such that a passenger vehicle cannot pass it without traveling over a portion of the raised pavement. A speed cushion is often a preferred alternative to a speed hump on a primary emergency response route or a transit route with frequent service. Additionally, MUTCD-compliant advisory signs are also recommended.

SPEED FEEDBACK SIGNS

A Speed Feedback Sign displays actual vehicle speed to drivers as they approach the sign (see Figure 17). The purpose of this sign is to reduce vehicle speeds by making drivers aware of their speed relative to the posted speed limit. Studies have found that speed feedback signs can be effective in reducing mean and 85th-percentile speeds.

Figure 17: Speed Feedback Sign (Source: Richard Drdul)

If used, the changeable message sign legend should be "YOUR SPEED XX MPH" or similar wording. The legend should be yellow on a black background or the reverse of these colors. Installation of a speed feedback sign is optional, but if used it should be installed in conjunction with a speed limit sign.

To discourage racing, the sign must be programmed to not display speeds that are well over the posted speed limit. In these instances, the sign is most often blank. The maximum speed that a Driver Feedback sign may display is outlined in Table 3.

Table 3: Maximum Speeds to Trigger a Speed Feedback Sign

Posted Speed Limit, (mph)	Maximum Speed Display Threshold, (mph)
20	30
25	35
30	50
35	55
45	70
50	75
55	80

MINI ROUNDABOUTS

A mini-roundabout is an intersection design alternative that can be used in place of stop control or signalization at physically constrained intersections to help improve safety problems and excessive delays at minor approaches. Mini Roundabouts are not traffic calming devices but rather are a form of roundabout intersection. Figure 18 presents an example of a mini roundabout. Mini Roundabouts should only be considered in areas where all approaching roadways have an 85th percentile speed of less than 30 mph. The central island of a mini roundabout is typically at least 13 feet in diameter and is mountable by trucks. The central island should be domed at a height of 0.3 to 0.36 in per 1 ft diameter, with a maximum height of 5 in. Although small and fully mountable it is essential that the central island be clear and conspicuous.

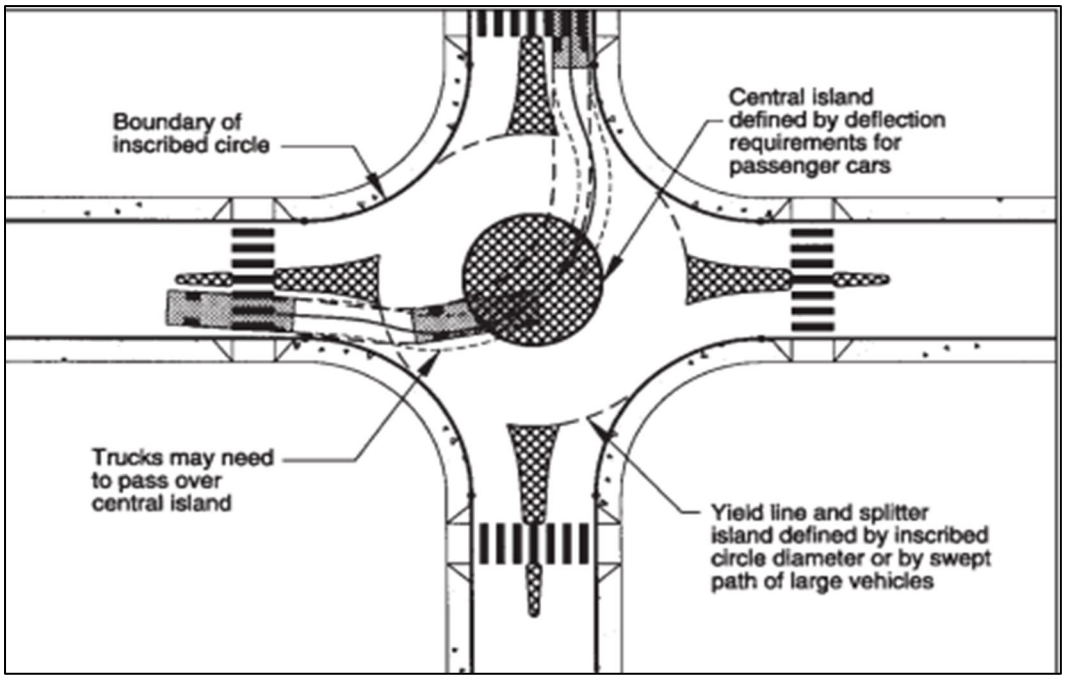

Figure 18: Mini Roundabout (Source: FHWA)

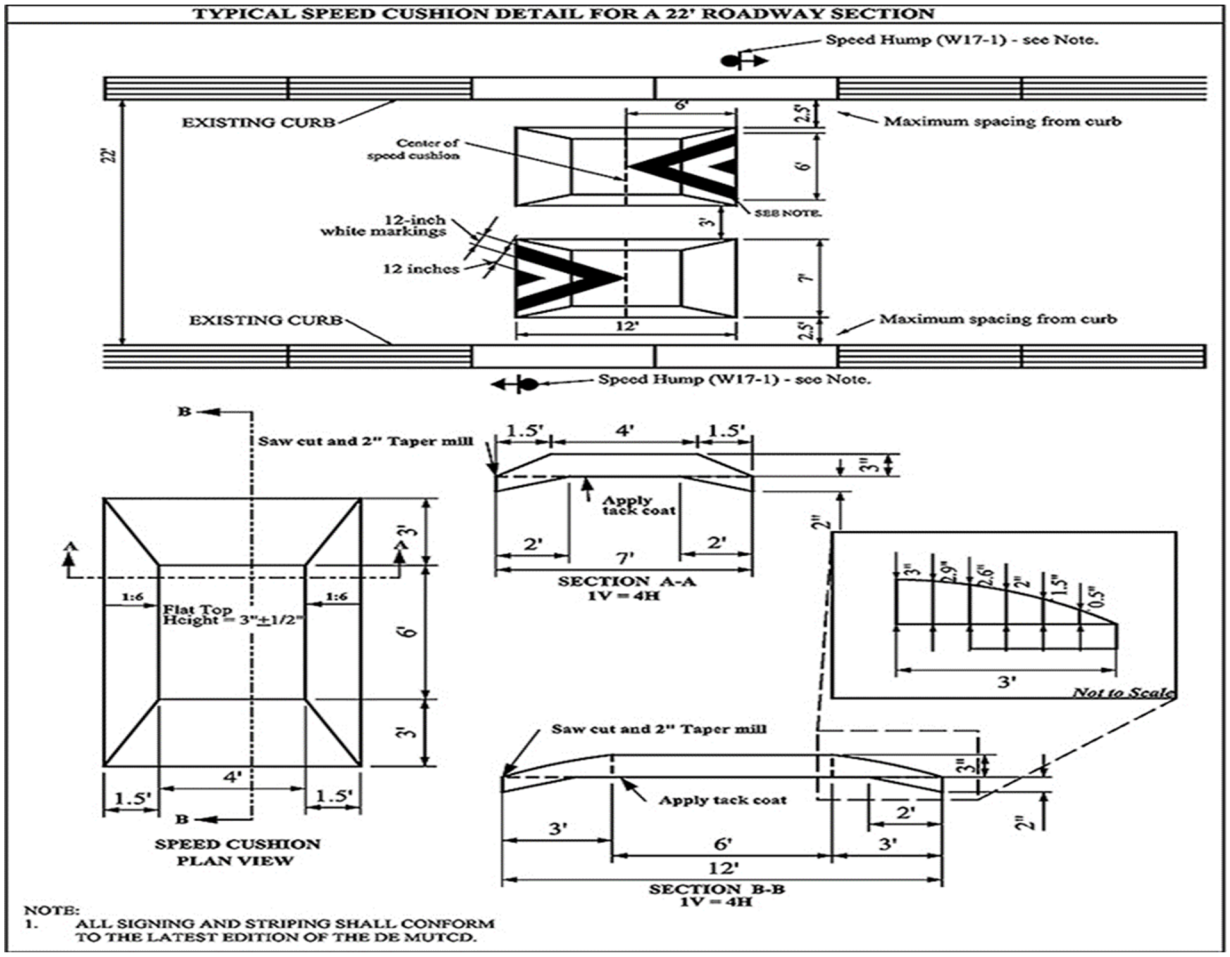

Figure 19: Speed Cushion

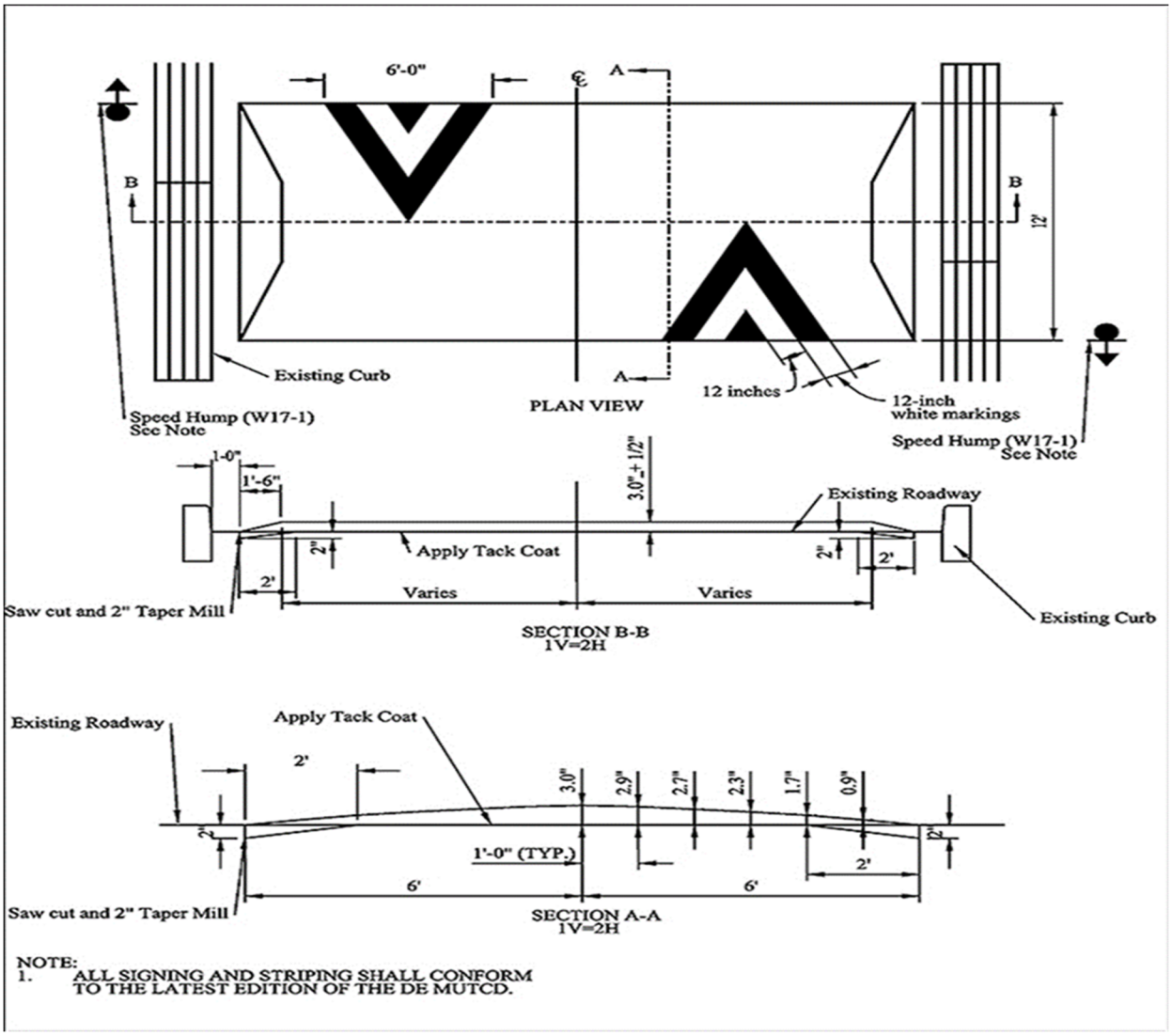

Figure 20: Speed Hump Typical Design

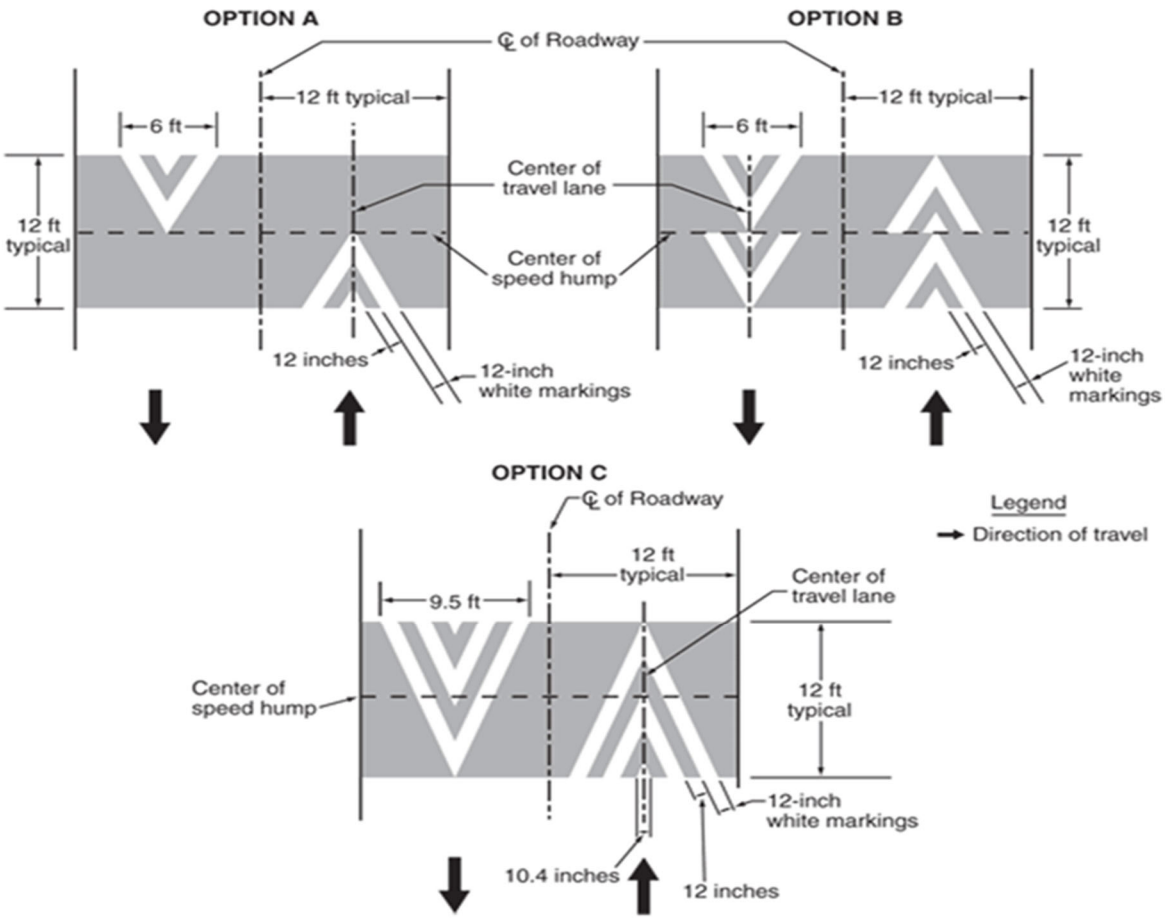

Figure 21:Speed Hump Pavement Markings

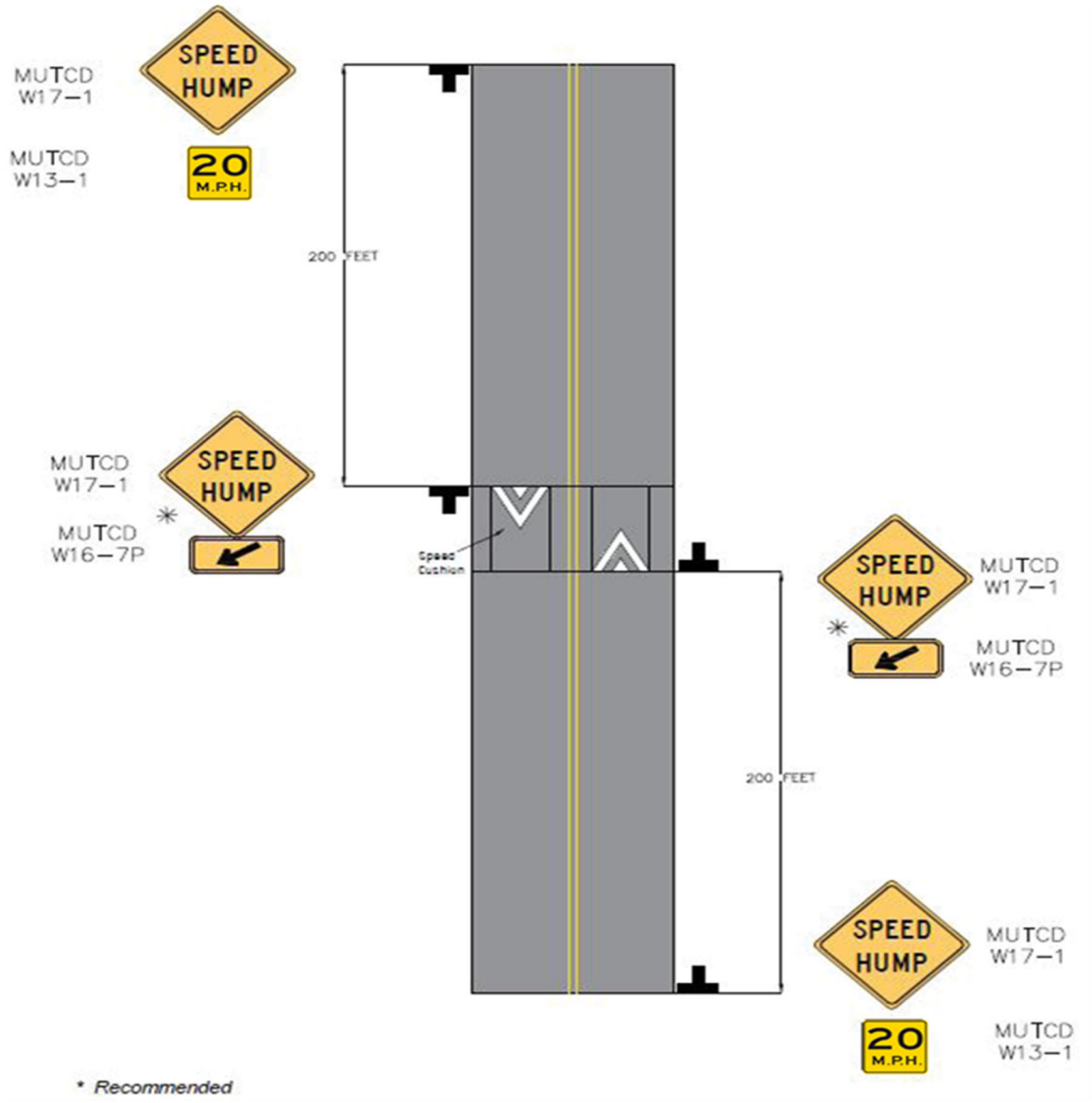

Figure 22: Speed Hump/Cushion Warning Signs (MUTCD)

APPENDIX B: ANALYSIS OF SPEED DATA

Below are the speed distribution charts for each road studied, see Figures 2 - 6. The x-axis shows the speed ranges, while the y-axis shows the number of cars in each range. The posted speed limit is 23 MPH. Speed data is collected and grouped or binned together as shown in the figures below. 23 MPH is not standard. Speed limit signs are typically in increments of 5s or 10s. Count station locations are shown in Figure 1.

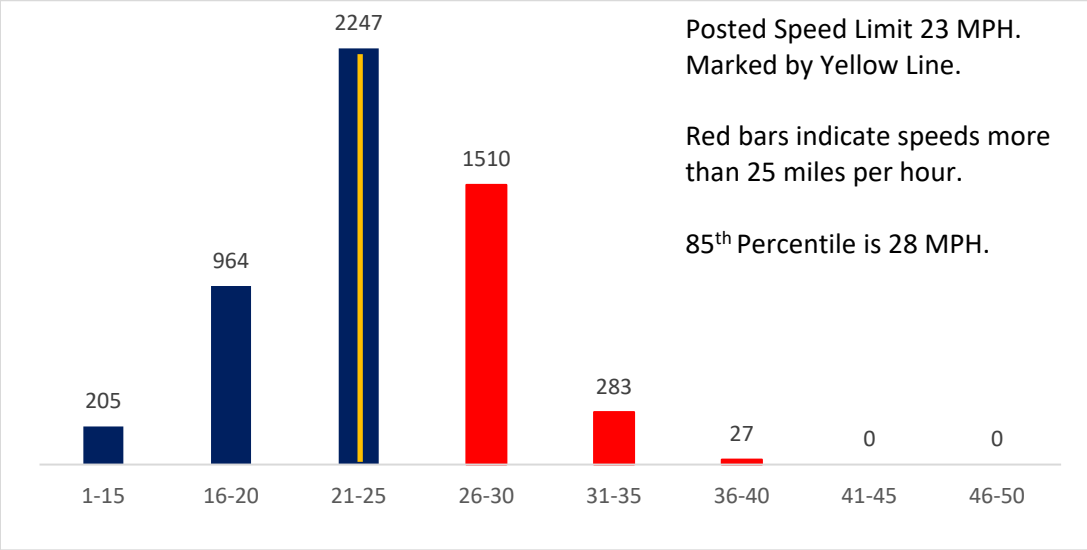

Figure 23: Legacy Falls Drive North – Count Station 1

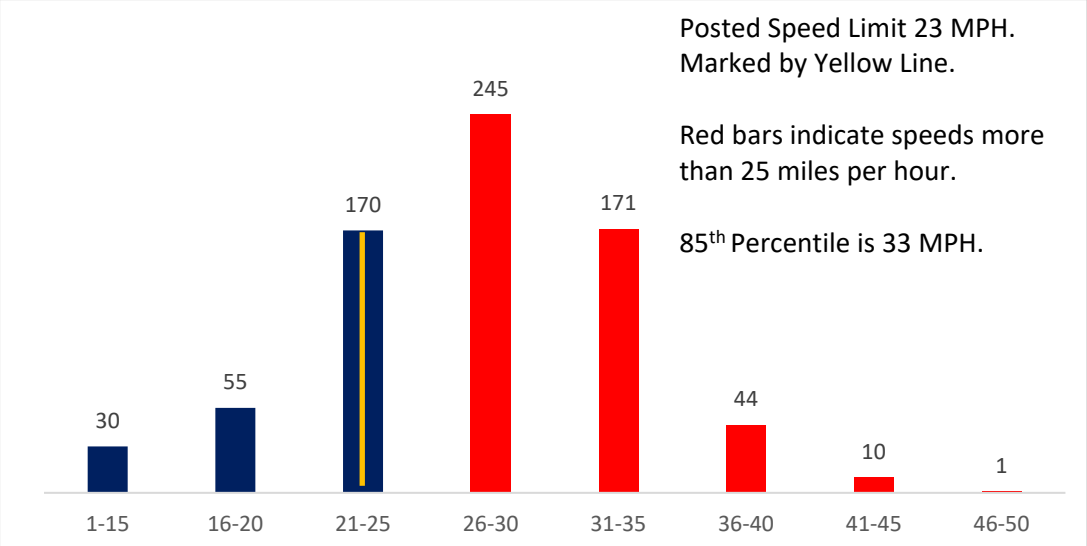

Figure 24: Legacy Falls Drive South – Count Station 2

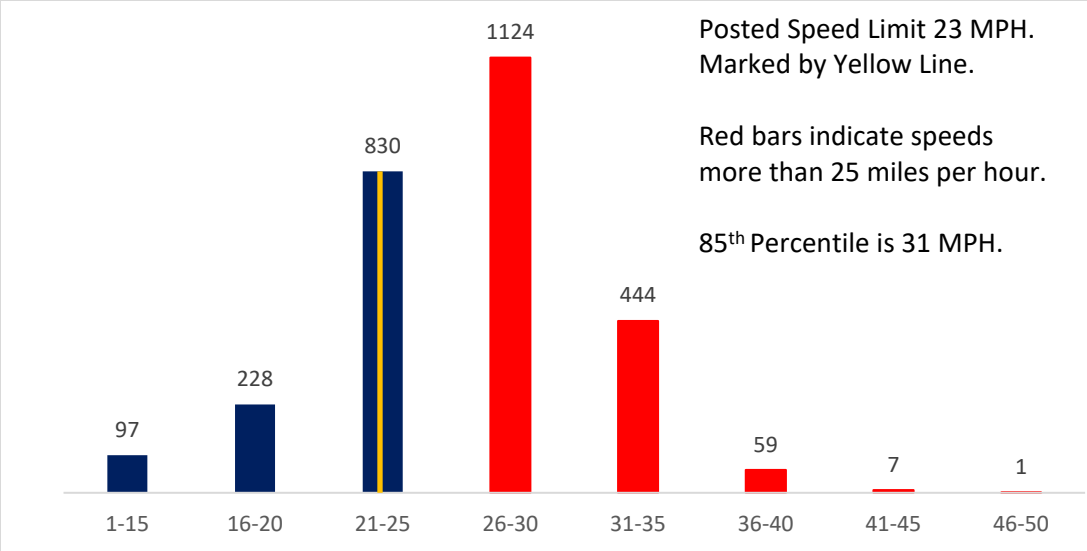

Figure 25: Covered Bridge Trail north of Rolling Meadows Lane – Count Station 3

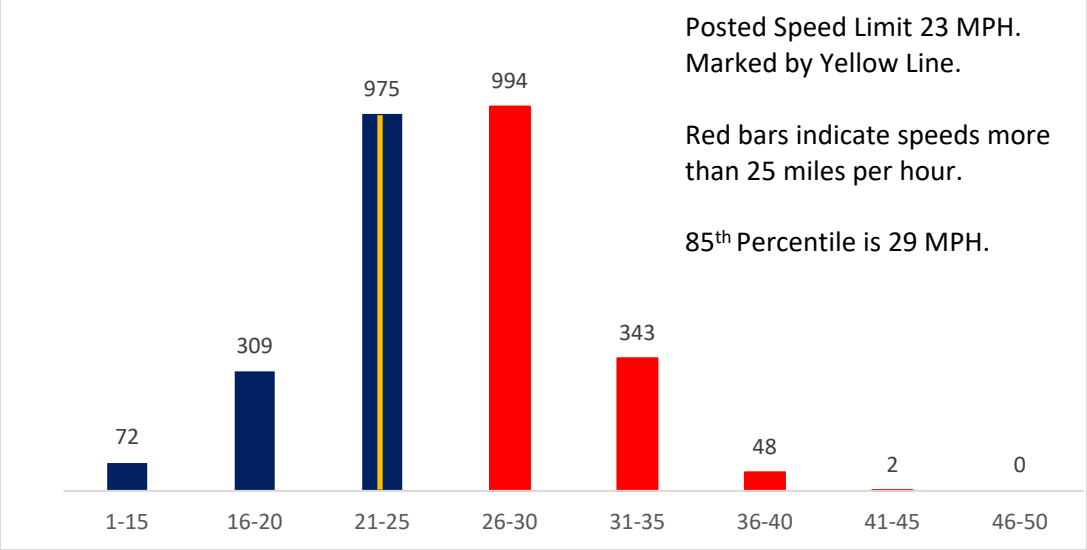

Figure 26: Covered Bridge Trail South of Stoney Creek Way - Count Station 4

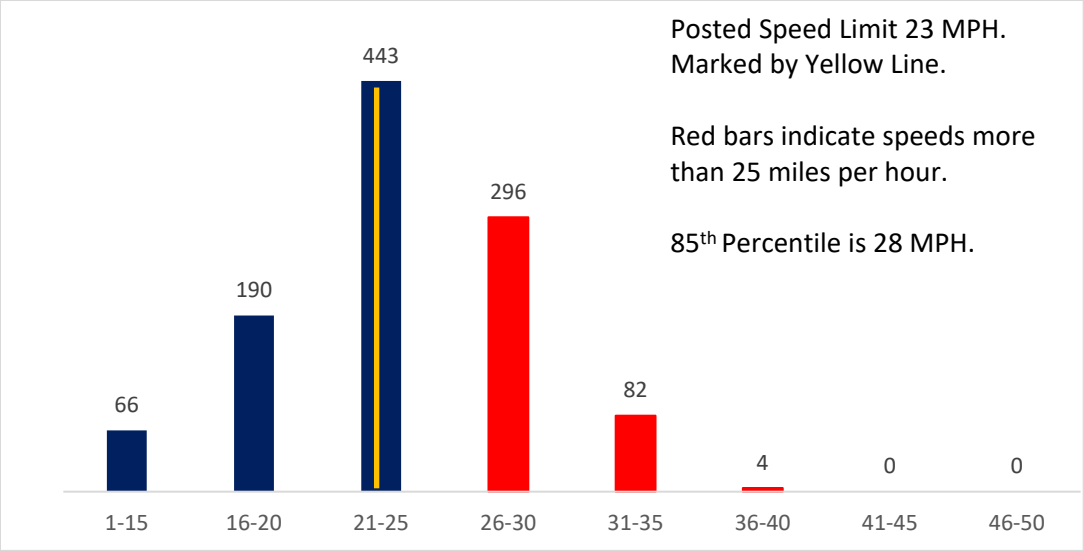

Figure 27: High Woods Ridge - Count Station 5

Based on the posted speed limit in Legacy at Jordan Lake of 23 miles per hour, the 85th percentile speeds are more than 5 miles per hour over the posted speed limit. The speeds for the count locations are shown in Figures 23 – 27 and Table 4 shows the mean and 85th percentile speeds. The 85th percentile speeds are indicative of a speeding problem in Legacy at Jordan Lake. The higher 85th percentile speeds indicate that the current speed limit could be too low, and the residents are comfortable driving at a higher than posted speed. Legacy at Jordan Lake could increase the posted speed limit within the development or install the traffic calming solutions provided.

Table 4: Mean Speed and 85th Percentile Speed

Counter	Street Name	NB & SB Mean Speed	NB & SB 85th Percentile Speed
1	Legacy Falls Drive N. of Legacy	23	28
2	Legacy Falls Dr. S. of Westlake Circle	27	33
3	Covered Bridge Trail N. of Rolling Meadows Ln.	26	31
4	Covered Bridge Trail S. of Stoney Creek Way	25	29
5	129 High Woods Ridge	23	28

Figure 28 shows the vehicle composition by percentage throughout the development. It is an average. Personal vehicles include cars, SUVs, pickup trucks, and personal trailers. Buses include school buses. Single Unit Trucks (SUT) include delivery trucks, service, and construction trucks. TTST vehicles include tractor-trailers and semi-trucks.

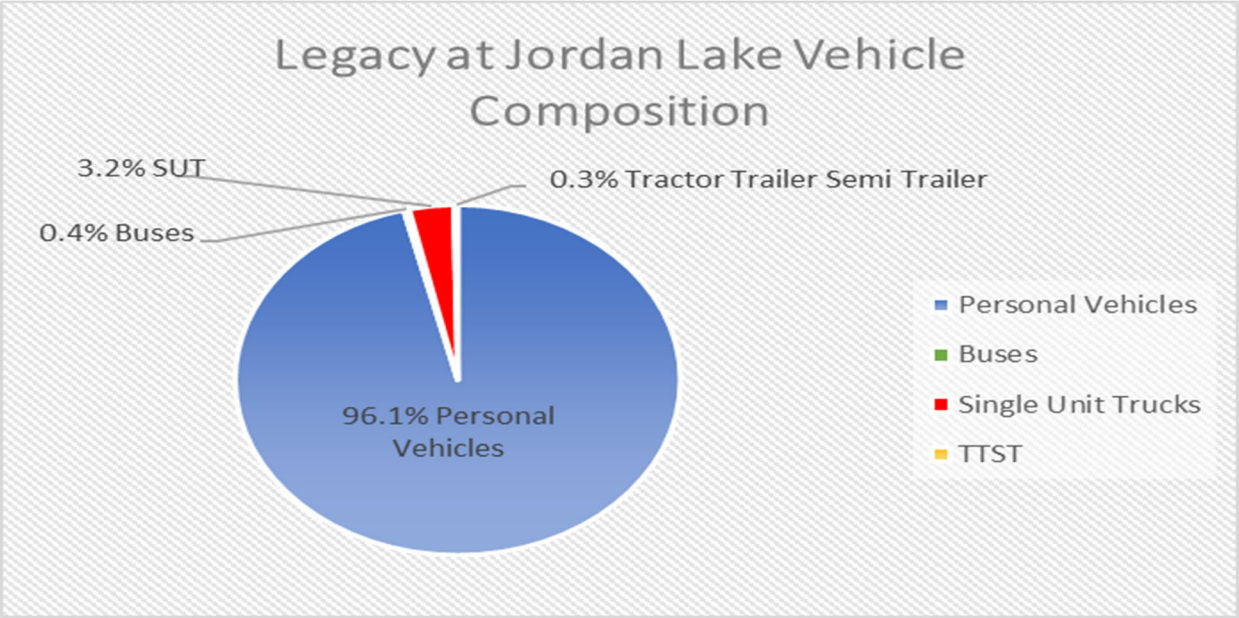

Figure 28: Vehicle Classification Data